

52-2-13  
Astronomy's Advancement,

Or,

*News for the Curious ;*

BEING A

TREATISE

OF

Telescopes :

AND

An Account of the Marvelous Astronomical Discoveries  
of late years made throughout *Europe* ; With the  
Figures of the Sun, Moon, and Planets ; with *Copernicus*  
his System, in twelve Copper Plates.

ALSO,

An Abstract touching the Distance, Faces, Bulks, and  
Orbs of the Heavenly Bodies, the best way of using  
Instruments for satisfaction, &c. out of the best Astro-  
nomers, Ancient and Modern, viz. Mr. *Hook*, Mr.  
*Bouilleau*, Mr. *Hevelius*, Father *Kircher*, &c.

A Piece containing great Curiosities.

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Done out of *French* by *Jos. Walker*.

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L O N D O N,

Printed for *Philip Lea*, Globe-Maker, at the *Atlas* and  
*Hercules* in the *Poultry*, right against the *Old-Fury*.  
1684.





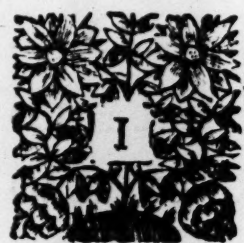
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T O T H E  
HONOURABLE

*Sir William Portman* Baronet,

And Knight of the *Bath*.

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I may truly be affirm'd that Nature made an equal Partition of all her Goods amongst her Children, the Eagle and Hawk for Sight, the Hound for Sent, the Lilly and Peacock for gay Cloathing ;  
A 3 Birds,

*The Epistle Dedicatory.*

Birds, Beasts, and Fishes went away alike satisfi'd and pleas'd with their State and Condition. Man in this Distribution (whilst he retain'd his Innocency) was Gods Vicegerent upon Earth, and besides the Enjoyment of the World, and the Command of all Creatures, he had also Fellowship with Angels; but failing of his Allegiance, he was soon degraded of his Dignity, and became subject unto manifold Miseries, and even to Death it self; yet in his fallen Estate there is to be seen some Marks of his Divine Original. The Heathen Poet sings of him,  
*Os homini sublime dedit Cælum-  
que*

## *The Epistle Dedicatory.*

*que tueri.* That he is not a Child of Earth like other Creatures, but chiefly made to Contemplate Heavenly things, of an erect Countenance, fitly fram'd with two Eyes, wonderfully made to view the Works of God's Hands. It is true, the Natural Imbecillity, as of others, so of our Visive Organs, doth not permit us to take so full a view as we could wish of Bodies that are always at great distances, therefore Men by their Industry have invent-ed Arts to supply this defect, and amongst many, the Telescope (which occasion'd the ensuing Treatise) is one of the

## *The Epistle Dedicatory.*

most useful and curious Instruments that has hitherto been discover'd. By the help of it, Men are in some measure restor'd unto their first Dignity, and somewhat enabled to see and Contemplate the wonderful frame and disposition of the Heavens and Heavenly Bodies, and thereby raise their thoughts and affections from Earthly gross and mean Objects, to such, which from a *Primum Mobile*, may advance them to the first Mover and Creator of all things. But as the Eye of Nature carries us but a little part of this way, so also this Artificial Eye falls very far short



*The Epistle Dedicatory.*

Short of the Mark ; and though it communicates unto us some imperfect glimmerings of the Stars, Firmament, and Lower Heavens, yet it there leaves us at a loss ; so that 'tis absolutely necessary to take some other help to guide us to the sight and fruition of the Supream Happiness, and that is the Eye of Faith, purely abstracted from all Sensitive Matter, which alone can penetrate through the Fogs and thick Vapours of the Air, and can like the Eagle stedfastly (through the Veil of the Firmament) behold the Sun of Righteousness. This Eye is only to be obtain'd by  
the



## *The Epistle Dedicatory.*

the constant and Conscionable hearing and reading the Word of God, which by some years Experience I observ'd you to perform, and question not your perseverance therein, having receiv'd as many and great Blessings from His Liberal Hand as any Heart can reasonably wish.

A Person of Quality, unto whom I have a thousand Obligations, was pleas'd lately to shew me the following Collections of Discoveries, made by many famous Astronomers of *Europe* touching the Planets and some others Stars, intimating  
that

*The Epistle Dedicatory.*

that the time would not be ill spent to render it into *English*. I being very sensible of his great Wisdom and Judgment, readily contributed my weak Endeavours to communicate it unto all that are Well Wishers unto these Sublime Speculations; And having for an Age past been ambitious to give some publick Demonstration unto the World (as I have done in several particular Rencounters unto your self) of my Gratitude for the many Favours you have been pleas'd on all occasions to confer upon me both in City and Country ; Although  
I

## *The Epistle Dedicatory.*

I cannot with a *D'Avenant* or *Cowley* fix your Illustrious Name amongst the Stars, by the Rolling Measures of Pindarick or Heroick Odes ; yet I do with no less hearty Resentments, according to my slender ability, here fitly place your great Name ( as a Member of the most famous Society in the World ) in the Front of the choicest part of the most Eminent of the Heavenly Stars and Planets ; And that it may for many Lustres of Ages , flourish and shine with them above, as you have done here below, and convey their happy

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TO THE  
READER.

**T**hey must be very great Strangers to the Genius of our Nation, that will go about to deny them to have made as great progress in Astronomical Speculations, as any others whatsoever. Yet knowing the active mind of Men is inquisitive after new things, meeting accidentally with this small Treatise of Telescopes, and finding it to have been received beyond Sea with a general



## To the Reader.

*ral Applause and Approbation, and  
Printed at Paris, Avec privilege  
Du Roy, and supposing it as fit  
as other Subjects to make a pro-  
gress into England, I thought it  
would be no disservice to the Curious  
to lend it my help and assistance  
in putting it into an English Garb,  
and in recommending its Fate un-  
to all Well-Wishers of the Ma-  
thematicks.*

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*An*



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*An Account of the Marvelous  
Astronomical Discoveries of  
late years made throughout  
Europe by the help of Tele-  
scopes, &c.*

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S E C T. I.

*Of Telescopes.*

**T**He Telescope or great Prospective-Glass was invented in the beginning of this Age, before which time none in the World had knowledge of it. Formerly it was made very little and short, but finding that it represented Objects much better being made in a larger form, it is now made 20, 30, and unto 60, or 80 foot long, whereby Objects at great distance are clearly and more distinctly seen and discovered. Some do judge  
B they

they may be made of such a capacity, or improv'd to such form, that by them may be seen the Inhabitants or Animals, which by some are pretended to be in the Moon; Wherefore according to the Opinion of Mr. Azout, the matters hereafter mentioned, appear but as Objects of 60, or 70 Leagues distant. We will here report the Testimony of several famous Artists and Astronomers, who by the means of this Instrument have made their Observations upon the Stars and Heavens, each in their own Country, viz. some at *Paris*, others at *Rome*, others at *London*, and others in several other places of *Europe*.

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## S E C T. II.

### *General Discoveries made by the help of Telescopes.*

1. **B**Y means of this curious Instrument, it hath been observed, that all the Planets and Stars, excepting the Sun, are so many *Opaque* and *Dense Bodys*, without any light whatever, but only what they borrow of the Sun.

2. That every one of the Planets, except the Sun, change their Faces like the Moon; so that *Venus* and *Mercury* do sometimes

times appear like a half Moon, and sometimes quite round, according as these Planets are found more or less opposite unto the Sun. That *Mars* sometimes appears in a Curvy Lin'd Figure. That *Saturn* shews himself as encompassed with a Ring. Touching *Jupiter* it is very marvelous, That there are discovered four little Stars that continually move Circularly about his Body, and which by that means cast a shade upon his Superficies. These things are undeniable Testimonies, that all these Planets have no other Light, but that which the Sun communicates unto them.

3. This Telescope doth also inform us, that each of these Planets, except the Sun, have spots in their Superficies, just as the Moon hath, and of the same kind of blackness.

4. The same Instrument hath also inform'd us, that each of these Planets, and the Sun also, together with the daily and Natural Motions, do besides, move themselves upon their Centers, some by the motion of Revolution, and others by that of Libration.

## S E C T. III.

*Discoveries in the fixed Stars.*

**T**Ouching the fixed Stars, it is marvelous that the same Four things which we have observed to be in the Planets, are also found to meet in them. Hereupon it is to be observed, that from time to time by help of the same Instrument, there is discovered new Stars in the Firmament, the which having appeared a certain time, do so decrease of their bigness, that they cannot any longer be discerned; and then afterwards, after the revolution of Months, Years, or Ages, do appear again, as if they were newly come into being. This Wonder hath given occasion unto Astronomers and Modern Optists to conclude, that it is the same with the Stars, as with the Planets; and that at least some of them, have Spots and Blemishes, and that they also move as those do, on their Centers; From whence it proceeds, that when their Spots are turn'd towards the Earth, they do not appear unto us; and when the Spots are turn'd t'other way behind, then they do appear by means of this great Luminary. This Remark imports an evident decision of the Question, unto this day controverted, to wit, whether



ther these Stars shine of their own proper Light, or of the Light borrowed from the Sun-Beams, and we must hold it in favour of the Affirmative, that they shine by virtue of the Illumination of this great Planet; which is the point we have Established in the first part of our *Anticopernicus*; There be a great many observable and curious things to be seen in this first Part. As for the Stars which are permanent, or do always shine, it may probably be said, that they always continue such, because that by their moving upon their Center, they have little or no Spots. Moreover this Prospective discovers unto us in the Heavens, a far greater number of Stars than what we can discern with the naked Eye. It discovers unto us in the Pleiades, in a Circle of one degree of Diameter which encompasseth them, the number of 46 Stars, whereas we can perceive in that little company but six, the seventh having disappeared a long time ago.

Behold here also another great marvel in the fixed Stars, which is, that when they are beheld with the Telescope, they appear so prodigiously small, that whereas *Zycho B.* tells us that those of the first Magnitude appear unto the naked sight about two Minets Diameter; they appear not unto us, according unto *Galileo*, but five Seconds of a



Diameter, which is twenty four times less. And whereas *Tycho B.* makes these Stars to be 60 or 70 times bigger than the Earth; at this time, on the contrary, they are found to be 200 times less than the Earth. Whereupon *Kepler* warns us, that with the Telescope the greatness of any fixed Star cannot be determined, because by how much the better the Glass is, by so much the lesser the Stars appear. It is a matter of surprise to hear, that all the Planets do appear greater in the Glass than they are, especially the lowest; and then again these fixed Stars on the contrary, with the same Glass, do appear smaller. I adhere unto this Opinion of the prodigious smallness of fixed Stars; Nevertheless at present I judge, that as to this matter, there is some kind of fallacy in our sight. Hereafter we will make a farther Demonstration.

Lastly, The Telescope has discover'd and decided the Question which hath been so long agitated amongst the ancient Philosophers, namely, what that is which we call the Milky Way, vulgarly in *French* the Way of *St. James*; for it has given us to understand, that 'tis nothing but an infinite multitude of small Stars, which by their nearness one to another, make up all that white Tract which we behold in the Heavens.

S E C T. IV.

*Of what has been Observed in the Sun.*

**B**Y help of the abovesaid Instrument, there has been observed upon the Convexity of the Body of the Sun, black Spots which are moveable, variable, and subject to change, and which do move regularly towards the West, finishing their Revolution in 26 or 27 days. Nevertheless *Hevelius* here traces these ways by bendings, sometimes Convex, and sometimes Hollow. The motions of these Solar Spots testify unto us, that the Body of the Sun turns upon his Center, with that motion. These Spots are not Celestial Bodies, as *J. Tarde* would make us believe, but rather Evaporations which rise from the Body of the Sun, after the manner of Vapours arising from the Earth, and forming themselves into Clouds ; which doth appear, inasmuch as these Spots are always changeable in their form, bulk, and configuration. Sometimes there appears a great number in the Face of this Star : sometimes but a few, and sometimes none at all. Some of these Spots shine and become lightsom, and others that shined become dark. To this purpose *Malapert* at *Arras* did dayly observe these Spots,

from the year 1618. unto the year 1627. and never found them return unto the same Configuration they had in all that time. *Scheiner* on the other hand observed them at *Rome* at the same time, and found them no otherwise than the former had done.

It were to be wished that some of these Solar Spots had remained fixed in the Body of the Sun, for that would have decided the great Question, to wit, if it be the Earth, or the Sun, which is immovable in the Center of the Universe.

Father *Kirker* with the help of this same Telescope, in his Description of the Subterraneous World, *Lib. 2.* finds and tells us, that this great Star is a Body of Fire, unequal in its surface, and compos'd of several parts, of a different nature, some whereof is fluid, and others solid; that it appears, that his Disque is a Sea of Fire, wherein is perceived a perpetual agitation of Waves of Flame. That in some parts may as it were be seen Burnings, and in others Spots, much like unto thick Smoak; that these Burnings, and these Spots are not without the Sun, but that they seem to proceed forth from his Disque, appearing and disappearing, increasing and decreasing, the Fire shewing it self casually amongst those black Smoaks, which are the Spots that we perceive in this great Luminary; In short they  
are





North Pole

Fig. 2

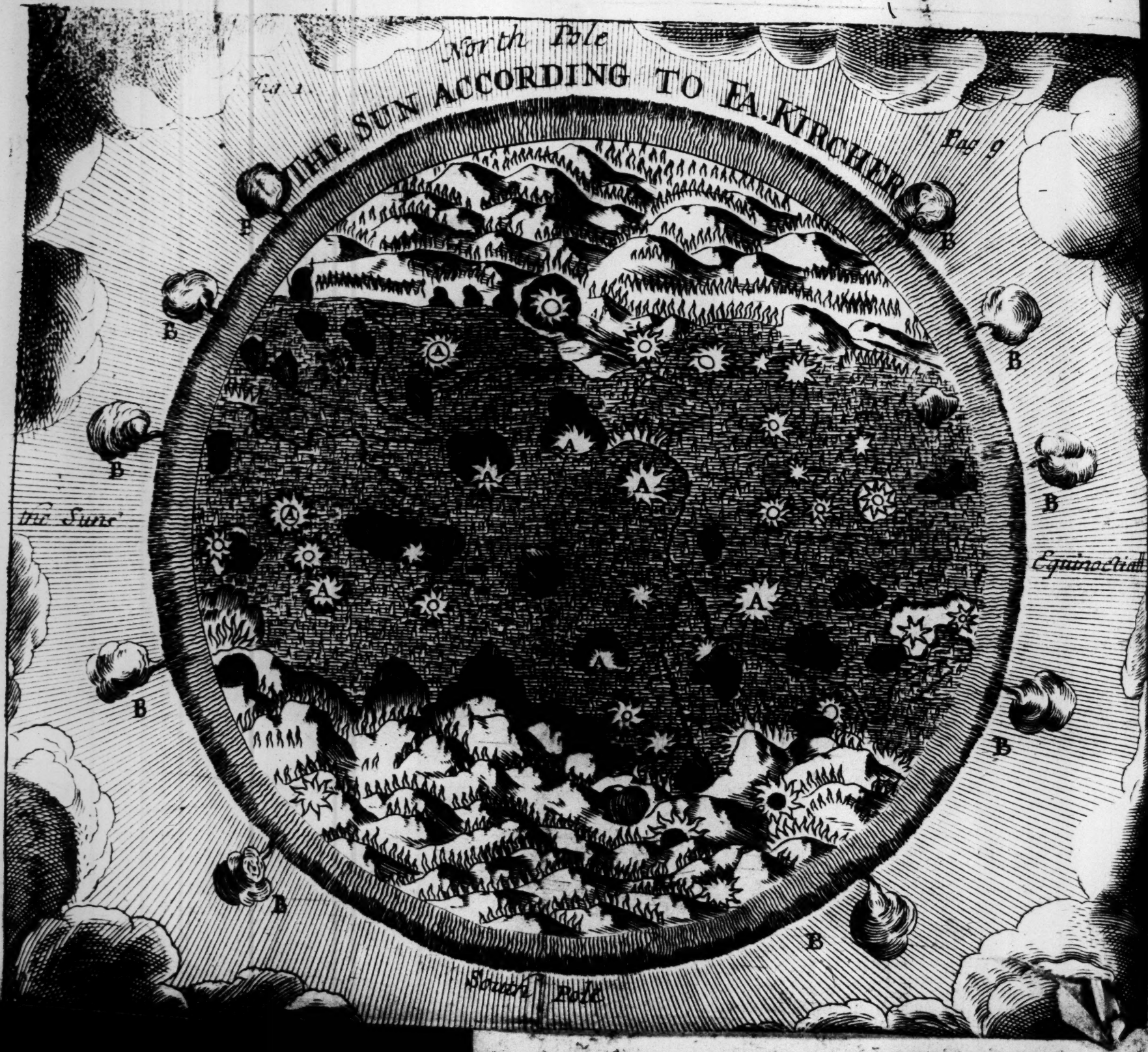
# THE SUN ACCORDING TO EA. KIRCHER

Fig. 9

the Sun

Equinoctial

South Pole





are the foams or froth of the Fire which the Sun exhales and evaporates out of its Body. Nevertheless Mr. *Azout* and Mr. *Hugens* do think, that these foams of Fire are only appearances occasioned by the undulation or waving of the Air. Some do esteem that these Solar Spots are the Seed and Matter whereof Comets are formed, which is not improbable. Moreover these same Spots of the Sun discover unto us, the reason wherefore in *Charlemain's* time, there was discover'd a Spot in this great Luminary.

Also, Wherefore at certain times it was, that this Star appeared not in his wonted brightness, as it happened in the year 1547, from the 24<sup>th</sup> of *August* unto the 28<sup>th</sup>: that the Sun appeared reddish, and not as bright as the Moon in her total Eclips, so that several Stars were visible at Noon-Day.

It happened to be the same for a whole year together at the time when *Cesar* was Murdered, insomuch that it was so darkened, that it could scarce ripen the Fruits of the Earth, *Virg. Geor. Lib. 1. & Ovid. Metam. Lib. 15.*

It was then by reason of Evaporations of the Sun which cover'd its shining face, and darkned its light, and diminished its heat.

## S E C T. V.

*Of what hath been Observed in the Moon.*

**B**ESIDES what is commonly to be seen in the Moon by the naked Eye, to wit, that she changeth her Face according as she turns towards the Sun, and that together with what Light she hath, she hath also black Irregular Spots; the same Instrument hath farther inform'd us, that the Lucid parts of her Body are Rugged and Protuberant, and as some conjecture, is like the Earth; and the rest which consists in Spots, as the same Authors say, resembles the Sea. Also that the Surface of this Planet is set all over with certain round hollows like Pits or Wells, of several Magnitudes, all and every of which, some unadvisedly take to be so many Mountains; but that they are rather a kind of Cavities, and liker Wells or Pits than Mountains, is apparent, in regard their shade is towards the Sun and not opposite, that is to say, beyond these Concavities or Wells.

And these be all the Shades which is remarkable in the Disque of the Moon, for to imagine as a great many do, that these Spots are so many Shadows produced by the Sun, by reason of Hills and Valleys, which  
all

all Antiquity supposed to be in the Moon, is not true; for when the Moon is full and opposite to the Sun, these pretended Shades in this Planet should by consequence disappear, which yet is not so. Note, That in our Figure, all the abovesaid hollows, are represented without shade, because being a Figure of the Full Moon, the Sun doth thoroughly enlighten them at other times, as at the Quarters, they shew themselves shaded in the part towards the Sun.

And although the Face of the Moon is full of Wrinkles, yet nevertheless there appears no Shadow, whether it be that the Shades of these Wrinkles are insensible for their smalness, or else that they be transparent to the Sun Beams, which is the Opinion of *Galileo*, who esteems the Moon to be like the Mother of Pearl, shewing knobs and redness where there is none.

It is true that some of these Wells or Hollows seem to be all black in the Full Moon, but that is without doubt, because that these Cavities are of the nature of the Spots whereof we speak.

The Diameter of these Wells or Pits consider'd in regard of the Moon, which contains about 650 *French* Leagues, contain some more some less; the greatest of all is that of *A. B.* which by computation contains about 20 Leagues.

Let



Let us farther observe in this Planet the admirable mixture of its Lucidities and Spots, those surprising Varieties, those Resemblances of Forests of Rushes which seem scatter'd here and there; those kinds of Spiders Legs: those kinds of Polygons, and especially the appearances of Beams of Light arising out of these profound Wells, as of the abovesaid *A. B.* To conclude, all the great variety of these things cannot seem to happen by chance, but that they were so disposed by the Sovereign Creator, for some end and reason unknown unto us; And indeed the Eighth *Psalms* informs us, that this Planet, as also the Stars, is the work of Gods Fingers.

Mark the word, Fingers.

All which being consider'd, and for other Reasons, we cannot say that the Moon is a World filled with Inhabitants, Animals, and Plants, as many ancient Philosophers have imagin'd; but rather a certain Vapour or Cloud, probably condensed with Cold, which is evident, inasmuch as this Star by day appears as a common Cloud; which Cloud were it raised to the height of the Moon, and that it were as big, it would shine in the Night after the same manner. Add hereunto, that the Pillar of the Cloud which conducted the *Israelites* in the Wilderness, was a Cloud by Day, and a Pillar  
of



of Fire by Night. We judge that all the Stars of Heaven, except the Sun, are of the same substance the Moon is of.

It is moreover a great wonder that this Nocturnal Light, appears unto us here below, to have borrow'd the likeness of a Womans Face in her Disque. *Plutarch* hath writ a Treatise expressly, wherein he saith this Figure of a Human Face, was in the Mouth and Hands of all the World; although it is certain that some of great Wit and exquisit Judgment, do protest they do not perceive any Image of a Womans Face in this Planet. - But *Plutarch* himself gives a Reason of this mistake, saying, that it is because those People have the sight low and weak, incapable of well perceiving the Lineaments of this Face; or rather, it is because their thoughts are not intent upon the Design, Picture, or Portraicture. For my part before I attained to be Six years of Age, I already fancy'd the form of a Face in this Planet, which also most People in the World think they do.

Besides let us observe this Face in the Moon with the Telescope, and let us consider it altogether, and severally; then you will say, this Human Face will no more be seen, but only certain Irregular Vapours without any order, which have no likeness unto any Representation whatsoever.

I. Our

1. Our Telescope hath also inform'd us, that there is first an Atmosphere, or Orb, which is supposed to be of a very thin Vaporous Air, which encompasseth all the Surfaces of the Moon; as round the Earth there consists the like Orb of Vaporous and Cloudy Air, which containeth the first Regions of the Air.

2. The Telescope hath farther given us to understand a thing very surprising in the Moon, which is, that in her Eclipse, when it is Eclipsed a Fingers breadth or two, to the Naked Eye, it is not at all Eclipsed if you look on it with the Telescope; and when it is quite freed from the Eclipse in the Telescope, it yet appears to be Eclipsed a Finger or two's breadth to the naked Eye. Upon this matter see the *Hydrogr.* of Father *Fournier*, wherein are given some Examples of this Phenomenon.

3. This Telescope hath farther given us the knowledge of a thing more strange and wonderful, to wit, that although the Moon being low near the *Horizon*, appears greater unto the naked Eye, and being mounted towards the *Zenith* appears less; it is found, that when its Visual Diameter comes to be measured in both these places, the quite contrary doth appear; to wit, that she is less when she is low near the *Horizon*, and greater when she is mounted towards the *Zenith*.

4. Let



THE FULL MOON ACCORDING TO M<sup>r</sup> HEVELIUS



the MOON in its  
Sextile Aspect according  
to Galileus



4. Let us instance in a fourth thing which relates unto the Moon, which is, that although for time out of mind, it hath been believed that the Longitudes of the World may be obtained by means of the Eclipses of this Planet; nevertheless Observations do not thereto agree, and do very much disagree from the Longitudes of our Maps of the World; whereupon see the *Hydrogr.* of Father *Fournier*, which gives a greater number of Examples. Let us add another point no less surprising, which is, that although that which is Illuminated in the Moon proceeds from the Rays of the Sun darted directly upon her; When this brightness comes to be examin'd, it is found that in all likelihood it is not carry'd in a direct Line, but in a crooked, and seems not to proceed from the Sun as from its Source, but ordinarily from another Principle higher and more eminent. God willing we will give full satisfaction of all these *Phenomena's* in a particular Treatise.

## S E C T. VI.

*Of what hath been discover'd in Saturn.*

**T**ime out of mind it hath been conceived that this Planet *Saturn*, consisted in one entire round Globe ; but now by help of this Telescope, we discover that it is composed of two parts, and that indeed it is round in respect of its Body, but doth besides consist of a Ring, which is Luminous by means of the enlightning of the Sun, as *Saturn* himself is Luminous by the same means ; which Ring encompasseth him all round after the same manner that the *Horizon* of our Artificial Globes encompasseth their Globes, and is flat upon the Verge as they be. Moreover this Ring shews not it self round, as a Circle seen direct, but shews it self in an Oval, as a Circle seen Obliquely. Some have at certain times found it twice and an half longer than it is broad ; others have found it decline from the Ecliptick 31 Degrees ; whereupon see here what is strange, which is, that upon certain Occurrences and Times this Ring disappears, so that at that time *Saturn* is alone and quite-deprived of his Ring, just as the Figures here do represent, whereof the 1, 2, and 3, do shew the manner



Page 17



Fig: 3.



manner that this Planet doth commonly shew himself with his Ring, and the 4<sup>th</sup> when he shews himself without a Ring, and quite round. Upon this change of Figure, wherein *Saturn* at certain times appears, Astronomers have well concluded, that in effect he moves in himself, and that it was necessary this Circle should be flat like a Bourlet; and that the reason wherefore he disappeared at certain times, proceeded, that at that time, he was as to us, turned Profil, and shewed us the side, and was not enlightned with the Sun on the side turned towards us. Moreover, Observations have given us to understand, that this Planet moves upon his own Center, and upon his own Ax, to wit, under the *East*, to the *West*, as has been observ'd by *Hugens*, *Cassini*, and others. Touching the Motion of this Planet Mr. *Hugens* has observed, that when it arrives at the 20<sup>th</sup> Degree and an half of *Pisces* and *Libra*, it appears round and without Arms. To this purpose in the year 1671. at the end of *May*, it appeared all round; and also in like maner it will appear all round in the year 1685. which is about fifteen years afterwards, which will also continue from fifteen to fifteen years, which is the moiety of the Natural Motion of this Planet, which 'tis known compleats his course in about thirty years.

C

Besides

Besides there is farther observed in this Planet a little Moon, which like the Satellites of *Jupiter* continually runs round his Body, and finisheth their course in the space of fifteen days thirteen Minutes. Mr. *Azout* thinks that in a few years the shadow of this same Moon may be seen upon this Planet.

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## S E C T. VII.

*Of what hath been Observ'd in the Planet  
of Jupiter.*

**W**ith the help of the same Instrument there is observed in the Face of *Jupiter*, and overthwart his Luminous part, three darkish Belts, like unto the Spots which appear in the Moon ; These Belts or Girdles which encompass or begirt this Planet, shew themselves all streight and parallel, and extend from *East* to *West*, near after the manner of the Ecliptick ; and do make as it were a kind of Equinoctial and Tropicks, of an Artificial Sphere ; Of his Belts the more Southern is a little larger than the Northern, besides that it is a little nearer the *South* than the other is unto the *North*. Mr. *Hooke* hath particularly observed also a little dark Filament, and where these

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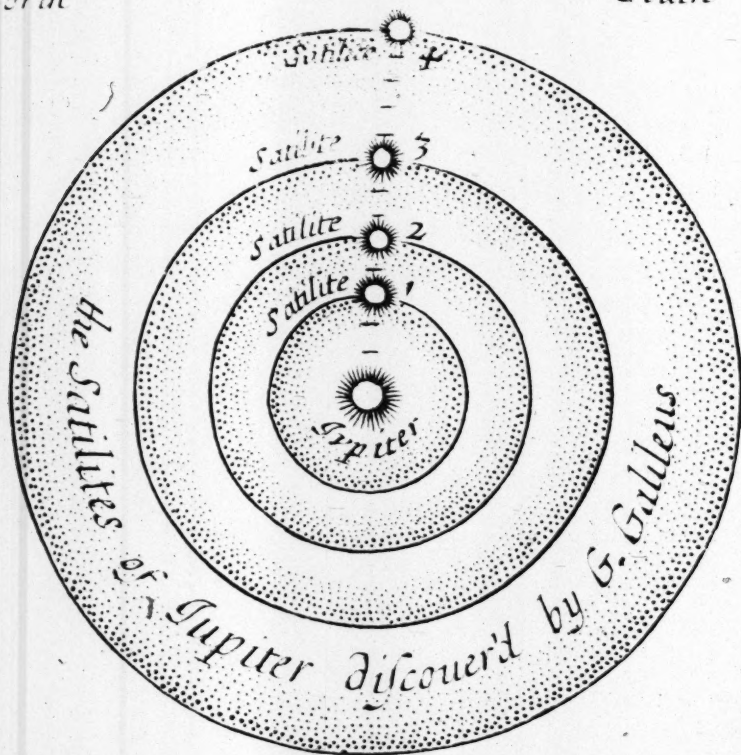
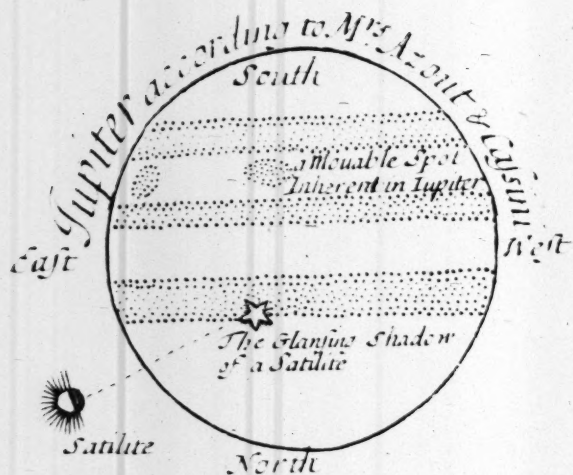


Fig. 4.



these Girdles or Belts draw nearer the *Poles*, the *Zones* grow darker, as in *A. B. Fig. 2.* Some Observators remark these Belts with some Curvity, but its border appears perfectly round, and without radiation.

Moreover this Planet hath four little Stars or Moons, which are not visible unto the naked Eye, which do continually move round his Body, and which do rise in the *East* of him, and set to the *West*. These four wonderful little Stars are called the Satellites, or the Guards of this Planet; they are diversly distant from *Jupiter*, and those nearest his Body finish their Revolutions with greater expedition than those that are farthest off.

1. The nearest of the Satellites is distant from *Jupiter* three minutes, and finisheth his course in eighteen hours, twenty eight minutes, thirty S.

2. The second Satellite is distant from *Jupiter* five minutes, and endeth his Revolution in three days, thirteen hours, eighteen minutes.

3. The third is distant eight minutes, and finisheth his Revolution in seven days, three hours, thirty five S. and is greater and brighter than the others.

4. The fourth Satellite is distant from *Jupiter* thirteen minutes, and endeth his

Course in sixteen days, eighteen hours, nine minutes, fifteen S.

It is to be observed that these Satellites do give a shadow upon the Body of *Jupiter*, when they are found interposed betwixt the Sun and him. Moreover Mr. *Cassiny* of late hath observed two moveable Spots upon the Face of this *Jupiter*, which do make their Revolution upon the Center of the same, tending towards the *West* in nine hours, fifty nine minutes; The which by Consequence doth testifie, that this same Planet moveth upon his Center from the same part likewise in nine hours, fifty six minutes. This Period is the shortest of all those that is made in the Firmament.

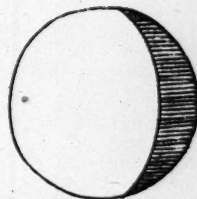
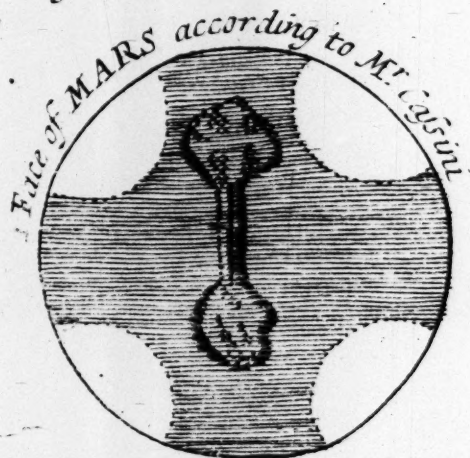
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## S E C T. VIII.

*Of what hath been Observ'd in the Planet of Mars.*

**A**Ccording to Mr. *Cassiny*, *Mars* doth move upon his Center and upon his Ax, under the *East*, towards the *West*, and with a Direction very like that of the Ecliptick, that is about twenty four hours, forty minutes each Revolution; the which he discover'd by means of two notable inherent movable Spots upon the Superficies  
of

Fig 21



MARS in his Quadrant according to Hevelius &c.



Fig 22

ie  
lo  
r,  
1

the Superficies  
of



of this Planet, and which do both finish their Course in the same space of time.

It is to be observed that *Mars* in his Opposition doth always appear round; but when he is betwixt the Conjunction and Opposition, he appears in a Curvy Line Figure; like the Moon when she is near her Opposition, before or after him.

S E C T. IX.

*Of what hath been Observ'd in Venus.*

**T**His Planet *Venus* appears sometimes round, sometimes half round, and sometimes like a Cressent. Mr. *Cassiny* took notice of it, and did not sufficiently, nor scarce at all understand it, until the year 1666. which he did not then neither, saith he, without much difficulty. He found that it had Spots upon its Surface just as the Moon has; to wit, two, which are very thin, long, and uncertainly terminated; amongst which at the seventh place marked 7, appears a shining part. He found by means of these Spots, that the motion of this Planet and of its Spots, was made upon its own Center, and upon an Ax which carry'd it from *South* to *North*, which is a motion wholly unknown in the Heavens;

and that this motion was accomplisht in one day, whether it be, saith he, of Revolution or Libration.

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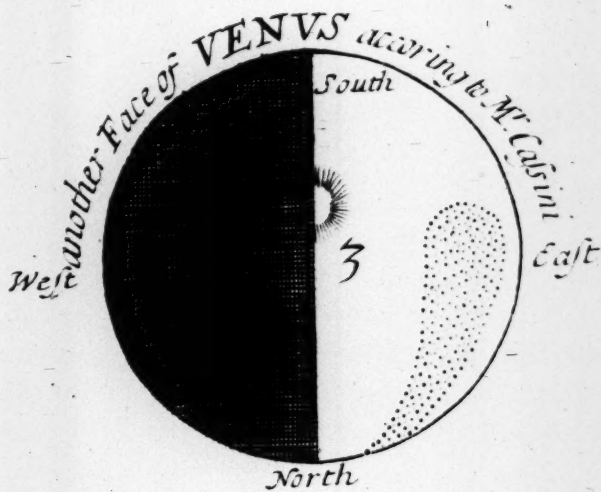
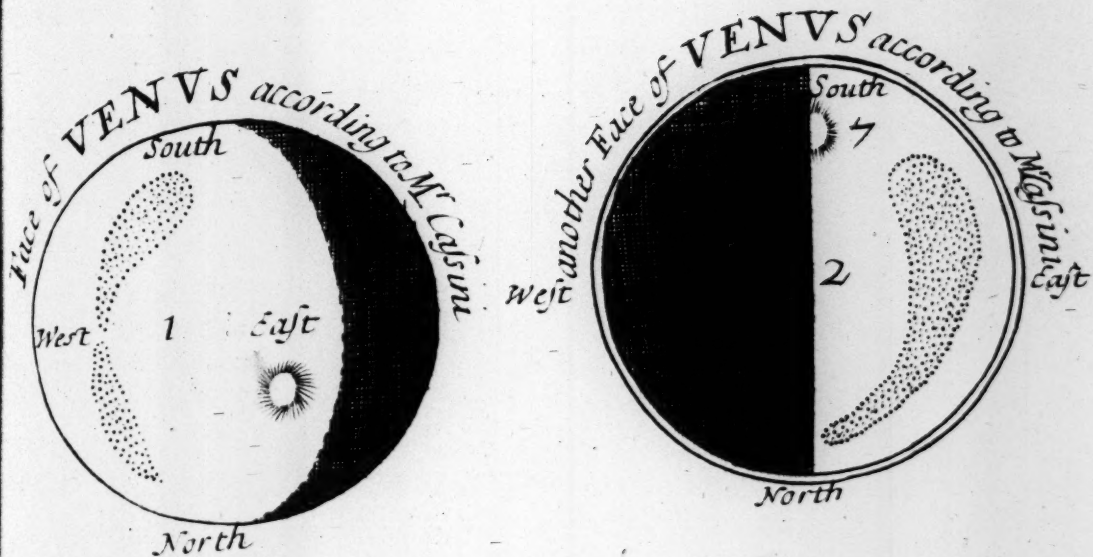
## S E C T. X.

*Of what hath been Observ'd in Mercury.*

**T**ouching *Mercury* we have no Observations can say that he hath Spots, as the other aforesaid Planets, nor can we determine whether he turns or not on his Center, or on some Ax; Nevertheless it is probable to believe, that it hath all things just as the other Heavenly Bodies. Moreover, *Hevelius* in the year 1644. observed, that he changed his Face, just as the Moon and *Venus*; and that he appeared sometimes round, sometimes half round, and sometimes like a Cressent. The reason wherefore this Planet is not discerned like the others is, because of his smalness, and for its being commonly darkned by the Sun Beams.

The 7<sup>th</sup> of *November* 1631. this *Mercury* was seen in the Disque of the Sun, as it were to Eclipse it; and there appeared like a Spot of the eightieth or ninetieth part of the Diameter of this great Star; It had its Center very black, and the Extremities something red.

SECT.







## S E C T. XI.

*Of new Stars which appear for a time, and then disappear at another time.*

And First,

*Of the first which came to our knowledge, and of the Notable One which appeared in the Chair of Cassiopea, Anno 1572.*

**T**He first new Star come unto our knowledge, is that which appeared in the time of *Hypparcus*, about 125 years before the Birth of our Saviour Jesus Christ; Since which time some others have also been discovered; to wit, one in the year 388. whereof *Claudian* makes mention: and one in the fifteenth Degree of *Scorpio*, spoken of by *Albumazar Haly*, the which continued four Months. Since which time, in the year 1571. the Ninth of November, there appeared in the Firmament in the Chair of *Cassiopea*, that notable Star of the first Magnitude, which in its Course governed it self like the other Stars, as holding place amongst them, and had no Parallax. The Astronomers of those times well observed it, for Instance *Tycho B.* it continued sixteen Months, after which time

decreasing very much, it grew quite invisible.

Upon the Consideration of this Star or Comet, is remarkable unto our purpose, what the Marquess of *Villenes* hath left in Writing in his Book upon the *Centiloqui* of *Ptolemy*; to wit, that there remained a black Spot in the same place where this Star appeared; which, if so, it would the more confirm what we have said, that the Stars have Spots just as the Planets have, the which makes them disappear at such times as they turn fromwards the Earth. Nevertheless seeing the Assertion of this Marquess is not seconded by other Authors, we will refer our selves unto farther Experience.

It is doubtful if this same Star will not come and appear again. All we can conclude of this Question is, that if it be a real fixed Star, it will not fail appearing some other time; but if it be only a Comet, or that it is in the Firmament it self, or a little below it, then it will never appear again.

SECT.

Page 24

The new STARR or Comet in the  
Constellation of Cassiopea observed by  
Tycho B<sup>r</sup>

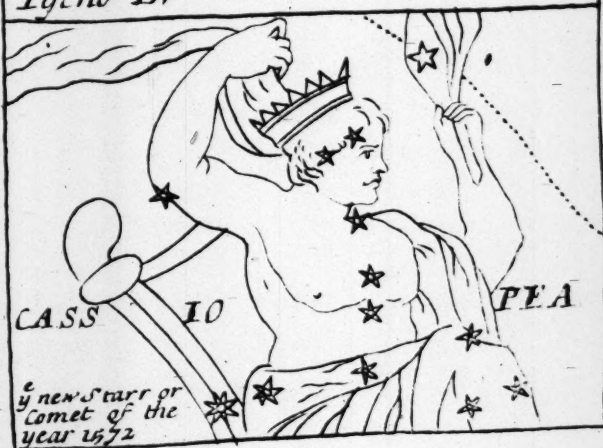


Fig. 7.





## S E C T. XII.

## Of the Star in the Swan's Breast.

Nine and twenty years after the Apparition of the Star in *Cassiopea*, viz. in the year 1601. there appeared in the Heavens a new Star of the third Magnitude, in the *Swan's Breast*, which continued visible unto the year 1626. and then totally disappeared. *Kepler* observed it very diligently.

After it had disappeared, and in the space of thirty three years, to wit, in the year 1659. Mr. *Hevelius* at *Dantzick* observed it to appear again in the same place where *Kepler* first saw it, and of the same Magnitude, but in the year 1660. it seemed plainly to diminish, and quite disappeared soon after. Again in the year 1666. Mr. *Hevelius* saw it re-appear, and it continues at present to be seen, but so small, that it is but of the sixth or seventh Magnitude! It is supposed that it is no less than fourteen years in finishing its Revolution; We have here represented it in *Tab. 8.*

of

*Of the Star near the Swan's Bill.*

This Star was first discovered by *Dom. Adthelm, Chartreux of Dijon*; to wit, in the year 1671. it appear'd unto him of the third Magnitude; It is not mentioned in any of the Catalogues of Stars, although a great many much more inconsiderable ones be therein mentioned. The same Father, and Mr. *Cassiny* have observed it as well in its increase as in its decrease; It hath twice appeared unto them in its greatest Luster: the first time the fourth of *April*, and the second time the first of *May*; it is about a Month in its return to its first state.

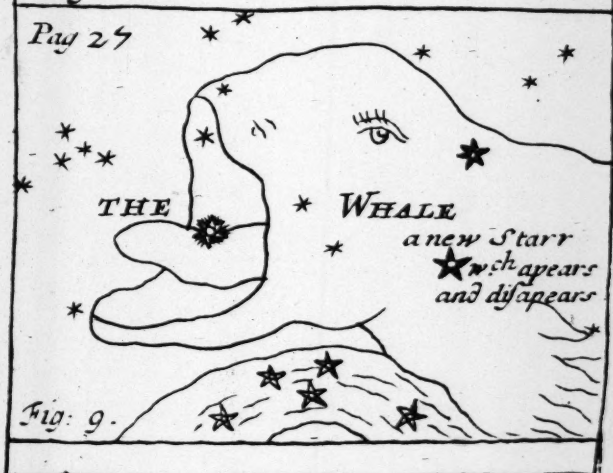
## S E C T. XIII.

*Of the Star in the Whales's Neck.*

**T**His admirable Star in the *Whale's Neck* is of this sort also which appear sometimes, then hide themselves, and then disappear again to appear at another time. At first it appears to be but of the sixth Magnitude, then it increaseth by little and little for 120 days together, after which time it arrives at its full period and greatest brightness and eminency, which is, to be  
of

*The new STARR in the Whales  
Neck discover'd by M<sup>r</sup>. Bouillau and  
Cabrini*

*Page 27*







of the third Magnitude, wherein it continues fifteen days together, then it decreaseth until it becomes invisible.

It doth appear every year in this greatest brightness, thirty two or thirty three days sooner than the precedent year, and compleats its Revolution in about three hundred and thirty three days. Mr. *Bovilleau* Astronomer hath very diligently observ'd it; he thinks it moveth upon its own Center and Ax; and presupposeth as we do, that it is composed of two different parts, the greater obscure, and the less bright; remaining invisible when the obscure part is turned towards us, and shewing it self when the bright part is towards us. Astronomers have judged that its motion is Irregular and inscrutable; nevertheless the said Mr. *Bovilleau* has invented a very ingenious Hypothesis, whereby he makes its motion to be Regular.

SECT.

## S E C T. XIV.

*Of the Cloudy Star of the Girdle of  
Andromeda.*

**F**ather *Fabry* and Mr. *Bouilleau* above-  
said, have taken notice of this Star;  
it appeared in the years 1612, and 1613.  
and then disappeared until the year 1664.  
that it appeared again anew.

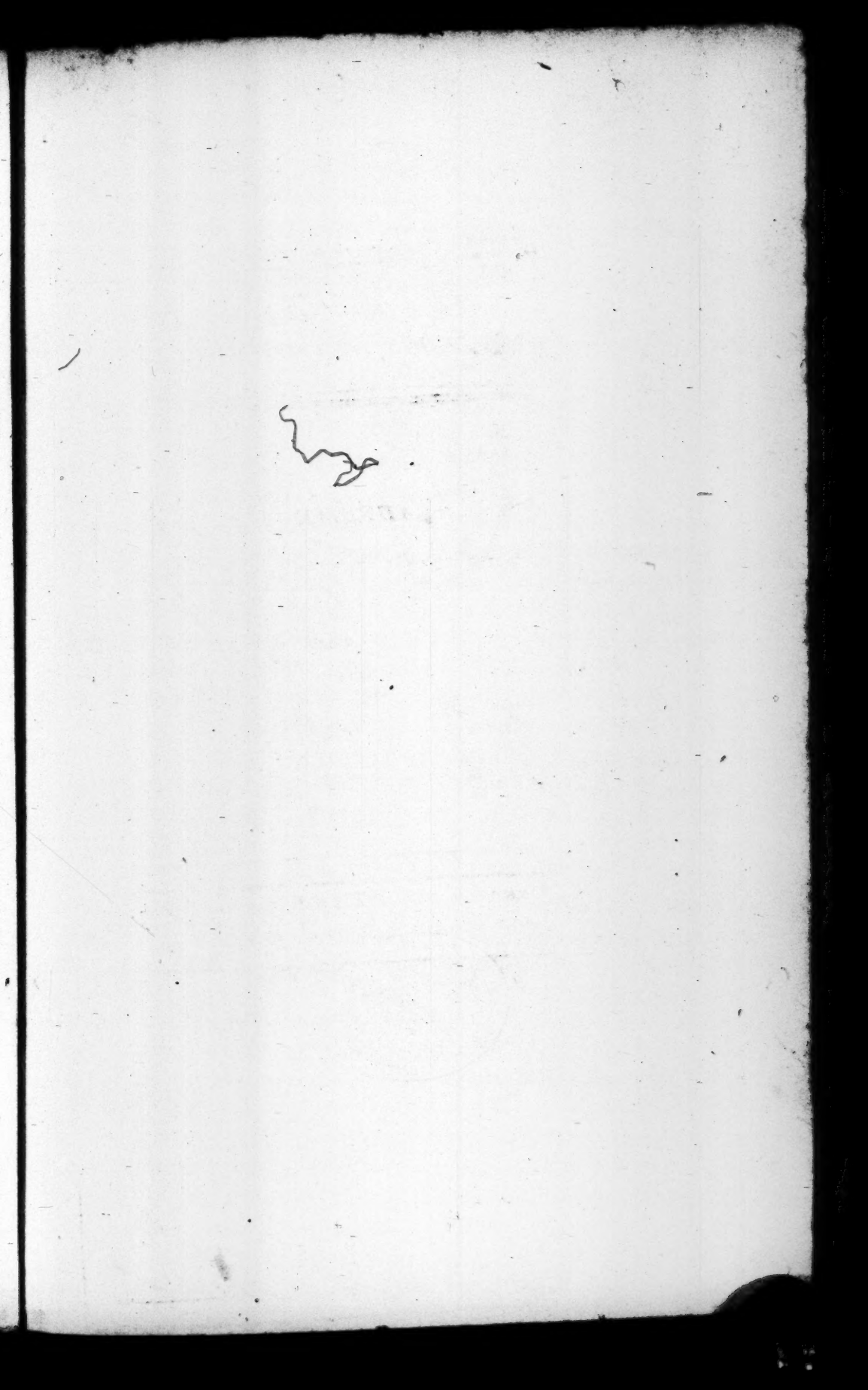
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## S E C T. XV.

*Of the Star betwixt Eridanus and those  
of the Hare.*

**M**R. *Cassiny* has discover'd another new  
Star situate betwixt *Eridanus* and  
the *Hare*, the which also shews it self, and  
then withdraws it self as the others above-  
mentioned, and is in the passage whereby  
the Comet in 1664. went. No body has  
spoken of this Star, although it be one of  
the fourth Magnitude.

SECT.



The Cloudy STARR newly disco-  
ver'd in y<sup>e</sup> Girdle of Andromeda observ'd  
by father Fabri and M<sup>r</sup>. Bouillau



Another new STARR betwixt Eridanus  
and y<sup>e</sup> Hare discover'd by M<sup>r</sup>. Cassini





## S E C T. XVI.

*Of other Stars, of which it is very probable  
that they are new Stars.*

**T**Here is one of the fourth Magnitude and two of the fifth in *Cassiopea*, which in all likelihood be new Stars, for several Astronomers having given an exact Account of far lesser Stars of this Constellation, yet have made no mention of these three. Moreover there is one of the fourth and one of the fifth Magnitude at the beginning of the Constellation of *Eridanus*, of which it is certain they were not there in 1664. because in that part of the Heavens the Comet of that year passed; and the very smallest Stars were diligently observed, whereas these which were far more considerable, were not observed.

Mr. *Cassini* hath also observed four Stars towards the Artick Pole, which are of the fifth and sixth Magnitude, which the Astronomers which have their Eyes always fixed on this part of the Heavens, would not have omitted to have inserted in their Catalogues, if they had ever appeared heretofore.

SECT.

## S E C T. XVII.

*Of Stars which have appeared heretofore,  
and now disappear.*

**T**ime out of mind there has seven Stars been observed in the Pleiades; The sacred Text, *Amos 8. v. 5.* seems to speak of this number, and probably also *Revel. 1.* and at present there is to be seen but six, a very probable sign, that one of them is retired and become invisible, after the manner of these abovementioned.

One of these of the Constellation of the *Little Bear*, which was formerly visible, doth not now appear.

Another also in the Constellation of *Andromeda* hath also disappeared.

That also in the Extremity of the Chain of *Andromeda*, in like manner hath disappeared, or at least is become so very small, that it is in a manner impossible to discern it.

Another which *Tycho B.* has inserted in his Catalogue for the twentieth of *Pisces*, hath also disappeared.

Now some may imagine that the above-said Stars may become invisible for a certain time, that the Sky in the place where they are, is thicker than ordinary, but that is

not

not it, because when these Stars become invisible, nevertheless the neighbouring Stars, although much smaller, and as it were imperceptible, yet are seen and discover'd; The new Star abovementioned which was in the passage of the last Comet, disappeared, whilst other less Stars in the same passage continued constantly to be seen.

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An

*An Abstract touching the Distance, Bulk, and Orbs of the Heavenly Bodies; The best way of using Instruments, &c. for satisfaction in the truth of the foregoing and like Discoveries; Out of the best Astronomers ancient and modern.*

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# S E C T. I.

*A Brief Method to satisfaction in the truth of the foregoing and all like Discoveries.*

**I**N order to make a true Estimāt of the certainty, or at least probability of the former Discoveries, I know no better way than to consider first the Distances of these Heavenly Bodies; then their Bulk and Bigness; next, their Spheres,



Spheres, or the Circumference of their Orbs; and lastly, the best means and times of making use of such Instruments by which exactest Discoveries may be made. All which we will set down according to the best and most usually received Accounts amongst the Learned, both ancient and modern, with all possible perspicuity and brevity.

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## S E C T. II.

**A** *lbatagnius* and *Alphraganus*, with others who have improved *Ptolemy's* Doctrine and Observations, adjust the distances of the Planets and Stars from us, by the Semidiameter of the Earth, taking that as the first and best common Measure; and the same measure have our Modern Astronomers taken up from them, for Reasons which may be touched hereafter. Now the Semidiameter of the Earth we cannot but think may be in a very tolerable sort computed and ascertained by reason of the great Improvements of Navigation, and the frequency of passing to and fro in a manner from Pole to Pole; I mean within few Degrees of each, and from the *East* and *West-Indies*, and back again, &c.

Now though there have been divers Opinions of the Compass of the Earth, yet it is now in a manner agreed upon that it is of 20255 *Italian* Miles; and that the Diameter thereof is 8354 such Miles; Therefore the half Diameter, or Semidiameter must be 4177 such Miles. Note, That the *Italian* Mile consists of 1000 Geometrical Passes; Now a Geometrical Pass contains five Foot, and must not be confounded, as by some Ignorant People it is, with our common Yard.

the quantity  
of an  
*Italian* mile

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### S E C T. III.

*Of the distance of the Moon from the Earth, the compass of her Orb, and bigness of her Body.*

According to those forementioned *Arabians*, the mean distance of the Moon (that is taking her when she is neither farthest off from, nor nearest to the Earth, but in a middle motion) is forty nine half Diameters of the Earth: that is about 110388 *Italian* Miles.

167400 =  
miles Eng-  
lish

This it is plain *Copernicus* thought too little, and therefore went not about any particular Calculation of her distance, but only in general has told the World, he looks upon

upon the compass of the year 1580 to be  
 will, that the Earth was not then  
 only as a Point: but *Ptolemy* having  
 made *Proclus* *Colophon* and *Calanus* from  
 us, affirms the distance of the Moon from  
 the Earth to be 60. of the Earth's Semi-  
 diameters: And *Ptolemy* *Lawrence* to  
 more, that of this same Semi-diameter

So that should we compute at the lowest  
 rate, taking *Proclus*'s Distance, the com-  
 pass of the Moon's Orb must be 1000000 of  
 6645343 Italian Miles. For its Diameter  
 made up of the Moon's distance from the  
 Earth twice taken, and of the Diameter of  
 the Earth will be 200000 Miles, which  
 multiplied by three (the Moon's Surface, to  
 avoid fractions) gives the Circumference  
 Sum; A vast Ground, yet far less than  
 of any of the Planetary ones.

Now as to the bulk or bigness of the  
 Moon's Body, it is estimated commonly by  
 the proportion it bears to the Body of the  
 Earth. Those that follow *Ptolemy* account  
 it thirty nine times less than the Earth  
 But *Geometric* tells us roundly it is about  
 forty three times less: *Lawrence* forty  
 five times and an half: And *Johannes* *Brach*  
 forty two. *But* *Lawrence* *Brach* *Brach*

There is another Measure which Astro-  
 nomers apply to Heavenly Bodies, which  
 they call a Degree; by that they measure

D 2



the quanti-  
ty of an =  
Italian mile

Now though there have been divers Opinions of the Compass of the Earth, yet it is now in a manner agreed upon that it is of 20255 *Italian* Miles; and that the Diameter thereof is 8354 such Miles; Therefore the half Diameter, or Semidiameter must be 4177 such Miles. Note, That the *Italian* Mile consists of 1000 Geometrical PASSES; Now a Geometrical Pass contains five Foot, and must not be confounded, as by some Ignorant People it is, with our common Yard.

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167400 =  
miles Eng-  
lish

This it is plain *Copernicus* thought too little, and therefore went not about any particular Calculation of her distance, but only in general has told the World, he looks upon



upon the compass of the great Orb to be so vast, that the Earth compared thereto is only as a Point; But *Tycho Brahe* having made stricter Observations and Calculations, affirms the distance of the Moon from the Earth to be  $56\frac{1}{2}$  of the Earths Semidiameters; And *Philippus Lansbergius* yet more, namely, of fifty nine Semidiameters.

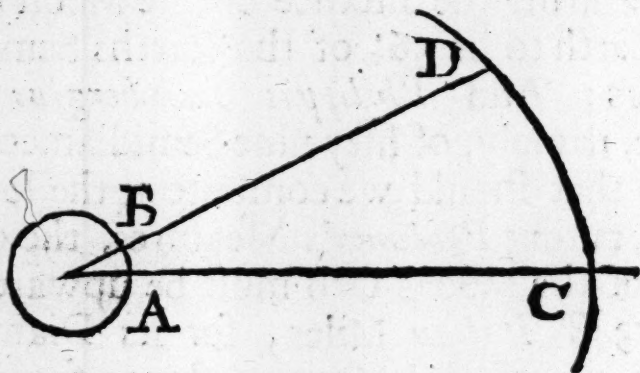
201600  
Engl. miles

So that should we compute at the lowest rate, taking *Ptolemy's* Measures, the compass of the Moons Orb must be upwards of 6645348 *Italian Miles*, for its Diameter made up of the Moons distance from the Earth twice taken, and of the Diameter of the Earth will be 2215116 Miles, which multiplied by three (the round number, to avoid Fractions) gives the forementioned Sum; A vast Orb indeed, yet far the least of any of the Planetary ones.

Now as to the bulk or bigness of the Moons Body, it is estimated commonly by the proportion it bears to the Body of the Earth. Those that follow *Ptolemy* account it thirty nine times less than the Earth; But *Copernicus* tells us roundly 'tis about forty three times less; *Lansbergius* forty five times and an half; And *Tycho Brahe* forty two. *Utrum horum magis accipe.*

There is another Measure which Astronomers apply to Heavenly Bodies, which they call a Degree; by that they mean an

Arch of a supposed Circle in the Heavens answerable to a Line of 60 Miles on the Surface of the Earth, which will be best understood by the following Figure.



Let the small Arch intercepted between *A* and *B* be supposed to be 60 Miles in the Surface of the Earth, the Arch which answers it in a supposed and very far distant Circle in the Heaven will be the Arch intercepted betwixt *C* and *D* vastly larger, yet bearing a proportion to the lesser Arch in the Earth. The Arch then *C. D.* is a Degree in the Heavens as *A. B.* is a Degree on the Surface of the Earth. Now these Degrees they ordinarily subdivide into sixty parts, which they call Minutes or Scruples, and these again into Seconds and Thirds as they please. Thus measuring, the apparent Diameter of the Moon is esteemed to be thirty three Minutes and one third. And thus much of the Moon.

## S E C T. IV.

*Of the distance of Mercury and Venus from the Earth, the compass of their Orbs, and the bigness of their Bodies.*

**A**FTER what has been said of the Moon, all will be much plainer touching both the other Planets and fixed Stars, of which we will first consider *Mercury* and *Venus*, whom we thus put together, because they also, as the Moon, are commonly thought less than the Earth, though far more distant than the Moon.

*Mercury* is by the *Ptolomaicks* thought to be 11½ half Diameters of the Earth distant from the Earth; but by *Tycho Brahe* 1150; and by *Lansbergius* 1500.

Now if we will reckon according to *Ptolemy*, *Mercury* will be 480355 Miles distant from the Earth, which number if we double, and add thereto the Diameter of the Earth, viz. 8354, we have the Diameter of his Orb, viz. 969064 Miles; which number if we treble, we have near about the compass of his Orb, viz. 2907192 ——— but if we take the other Accounts 'tis vastly bigger.

As to his Body, *Ptolomey* supposed him 19000 times less than the Earth, (a prodigious mistake certainly) *Tycho Brahe*, who is more herein to be credited, only nineteen times less, (by which he should be above as big again as the Moon) and *Lansbergius* only twice less. His apparent Diameter is judged only of two minutes or thereabouts, but *Martinus Hortensius*, a Disciple of *Lansbergius*, making use of his Telescope, admits *Mercury's* Body to be only nineteen Seconds; which Computation may be amongst others a good reason for his being so seldom seen.

*Venus* comes next; By the *Ptolomaick System* distant from the Earth 618 Semidiameters of the Earth; By the *Tychonick* 1150; By *Lansbergius's* 1500.

Now if we will reckon again according to the lowest rate, which is that of *Ptolomey's*, *Venus* will be 2581386 — Miles distant from the Earth; which number if we double, and add thereto the Diameter of the Earth, viz. 8354, as above, we have the Diameter of her Orb; and that number if we treble, as before, we have (nearly) the Compass of her Orb, viz. 15513378 — which yet it is apparent others would make vastly larger.

As



As to the bulk of this glorious Star, *Ptolomey* makes it twenty eight times less than the Earth, *Tycho* only six times less, and *Lansbergius* but three and a third part. Her apparent Diameter according to the first is of three Minutes; according to the second of three and a quarter; but *Martinus Horrensius*, a Disciple and Assistant of *Lansbergius*, observing her by good Telescopes, supposes her Diameter only of fifty nine Seconds.

---

S E C T. V.

*Of the distance of the Sun from the Earth, the compass of his Orb, and bulk of his Body.*

**T**He mean distance (for of that all along we would be understood to speak) of the Sun from the Earth, the *Ptolomeans* reckon to be 1165 Semidiameters of the Earth; The *Tychonians* but 1150; (the same as of *Venus* and *Mercury*) *Lansbergius*, &c. 1500. as he also had judg'd of these two last Planets.

Whence, if we should compute at our former rate, it would follow that the Sun is distant from the Earth about 4866205 — Miles; which number, if, as before, we

double, and add thereto the Diameter of the Earth, we have for the Diameter of the Solar Orb 9740764 Miles; and that if we multiply by the round number of Three to avoid Fractions, as before, we have for the compass of that Orb 29222292 Miles. The Body of the Sun, which is the greatest of all the Heavenly Bodies, is by the *Ptolemeans* judged to be 167 times greater than the Globe of the Earth and Sea; yet do they reckon his apparent Diameter only thirty one Minutes and one third, that is just two Minutes less than the Moon appears to us. *Copernicus* esteemed it only 162 times bigger than the Earth. But *Lansbergius* 434. And *Tycho Brahe* much less than either, only 139 times bigger than the Earth, and his apparent Diameter of thirty one Minutes still less than the apparent Diameter of the Moon; however his Body in it self be so vastly bigger.

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## S E C T. VI.

*Of the distances of the other Planets from the Earth, the compass of their Orbs, and bulks of Body.*

**W**E will now cease to compute the distance of the Planets by Miles, as being

being too small a measure, and running Figures to too great a length; The method is open enough, and any who have the curiosity to know the distance by Miles may be supposed to have the industry also, if they please, to calculate it themselves.

*Mars's* mean distance from the Earth according to *Ptolomey* is Four thousand five hundred eighty four half Diameters of the Earth; his apparent Diameter of one Minute and an half; and his Body once and an half bigger than the Earth. According to *Tycho* he is only One thousand seven hundred and forty five Semidiameters of the Earth distant, and his apparent Diameter of one Minute and three quarters, and his Body thirteen times less than the Earth. Which last point of his Opinion *Lansbergius* favours so far as to allow him to be eight times less than the Earth, but distant from it Two thousand two hundred and seventy five of its Semidiameters. Now *M. Horstenius* runs him so low as to reckon his Body to be One thousand five hundred and thirty four times less than the Earth, and his apparent Diameter only of thirty six S. And according to our former rate and method, we shall have for the Diameter of his Orb Nine thousand one hundred and seventy Semidiameters of the Earth, and for the compass of his Orb 27410 of the same.

*Jupiter's*



*Jupiter's* mean distance is according to *Ptolomey* Ten thousand four hundred and twenty three Semidiameters of the Earth; his apparent Diameter two Minutes and an half; and his Body eighty one times bigger than the Earth. According to *Tycho* he is only Three thousand nine hundred and ninety Semidiameters of the Earth distant from it; his apparent Diameter much at the same rate as the *Ptolomeans* judge it; but his Body only fourteen times bigger than the Earth. *Lansbergius* makes him Eight thousand and ninety one Semidiameters of the Earth distant from it; his Body but twenty five and two fifth parts bigger than the Earth. *Hortensius* but one and one fourth bigger, and his apparent Diameter only of fifty Seconds. And following still our former Computation upon *Ptolomey's* Doctrine (the proportions of his System being a mean between the vast one which *Copernicus*, and the narrower which *Ty. Brahe* introduced) we shall have for the Diameter of his Orb Twenty thousand eight hundred and forty eight Semidiameters of the Earth, and for the Compass or Circumference thereof upwards of Sixty two thousand five hundred and forty four of the same.

*Saturn* the highest of the Planets comes last, whom *Ptolomey* placed Fifteen thousand and eight hundred Semidiameters of the

the



the Earth distant from it ; *Tycho* but Ten thousand five hundred and fifty ; yet *Lansbergius* allows the distance to be Fourteen thousand eight hundred and eighty of the Earths Semidiameters. His apparent Diameter is judged by none, above one Minute and some odd parts, however his Body is according to *Ptolomey* seventy nine times, according to *Lansbergius* forty six, according to *Tycho* but twenty two times bigger than the Earth. And at our old rate, the Diameter of his Orb will be about Thirty one thousand six hundred and two Semidiameters of the Earth, and the compass of his Orb about Ninety four thousand eight hundred and six of them. Thus far then of the Planets, their mean distance from us, their bulk, and Orbits.

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## S E C T. VII.

*Of the fixed Stars, their Magnitude and Sphere.*

**B**Ecause some have judged certain Comets to have mounted as high as the Sphere of the fixed Stars, being that they were not able to observe they had any Parallax, we will therefore here consider those Stars as we have done the Planets.

*Ptolomey*

*Ptolomey* (at least the forementioned *Arabians* deducing it from his Principles) have placed the fixed Stars Nineteen thousand Semidiameters of the Earth distant from it. *Tycho* honestly telling us, that no exact or certain measures can be taken in this case, conjectures them to be near about Fourteen thousand such Semidiameters distant. As to the *Copernicans* they have another way of measuring, of which anon.

The fixed Stars are judged very far from being all of a bigness; And since the invention of Telescopes, it is certain there are a multitude of them either so small, or so far off us, that they cannot be seen by our naked Eye; however according to the usual estimate, they are taken to be of six several Magnitudes. Those of the first rate are conceived One hundred and eight times bigger than the Earth; such are, the bigger Dog-Star, the Bulls-Eye, &c. Those of the sixth and least rate only eighteen times bigger than it, according to *Alphraganus* his Account; but *Albategnius*, his Brother *Ptolomaick*, varies a little, not very much worth insisting on. However behold his whole estimate of all the Mundane Bodies. If we compare (says he) all the Mundane Bodies as to their bigness, we must acknowledge the Sun to take the first place, as biggest of them all; next him the six Stars of the first Magni-

*Magnitude; in the third place Jupiter, in the fourth Saturn, in the fifth the rest of the five Orders of the fixt Stars, according to their Magnitudes of 2, 3, 4, 5, and 6<sup>th</sup> Rate, in the sixth place Mars, in the seventh the Earth, in the eighth Venus, in the ninth the Moon, in the tenth and last Mercury. This is also generally the Ptolomeans Opinion of the several Bodies in this Systeme of the World.*

But I suppose it must be understood only of such fixt Stars as they knew; for before the invention of Telescopes, that infinite number of Stars which makes up the *Galaxy*, or *Milky Way*, that great number also in the Constellation of the Pleiades, not seen to the naked Eye, as also the innumerable number *scattered through the Heavens*, discoverable by the help of our Glasses, were not known, nor therefore estimated.

The Diameter of the Sphere of fixt Stars, if taken according to our old Rule, is about Thirty eight thousand and two Semidiameters of the Earth: and therefore its compass upwards of One hundred seventy four thousand and six such Semidiameters.



## S E C T. VIII.

*Of the Opinion of the Copernicans in these points, and the advantage of their Systeme.*

**N**OW Copernicus and his Followers placing the Sun in the Center of the World, and supposing the Earth to be moved both upon her own Center daily, and annually about the Sun, (which is far the most probable of any of the Mundane Systemes) measure the distance of the Sphere of fixed Stars by the Semidiameters of the great Orb; And the great Orb they call the Sphere of the Earths annual motion about the Sun. For the full understanding hereof, behold here the Systeme (or Fa-  
brick of the World) according to the Copernican supposal.

The outermost Circle is the Sphere of the fixt Stars: The second is the Orb of *Saturn*, marked  $\text{h}$ : The third of *Jupiter*, who is placed in the four less Circles, *A. B. C. D.* in each of which Circles is a little Star (called one of his Satellites, or Life-guard-Men) moving round him: The fourth great Circle is the Orb of *Mars*, marked  $\text{♂}$ : The fifth is the Orb of the Earth, marked  $\text{4}$ , about whom in a little Circle, the Moon is by them supposed to move Monthly: The  
sixth



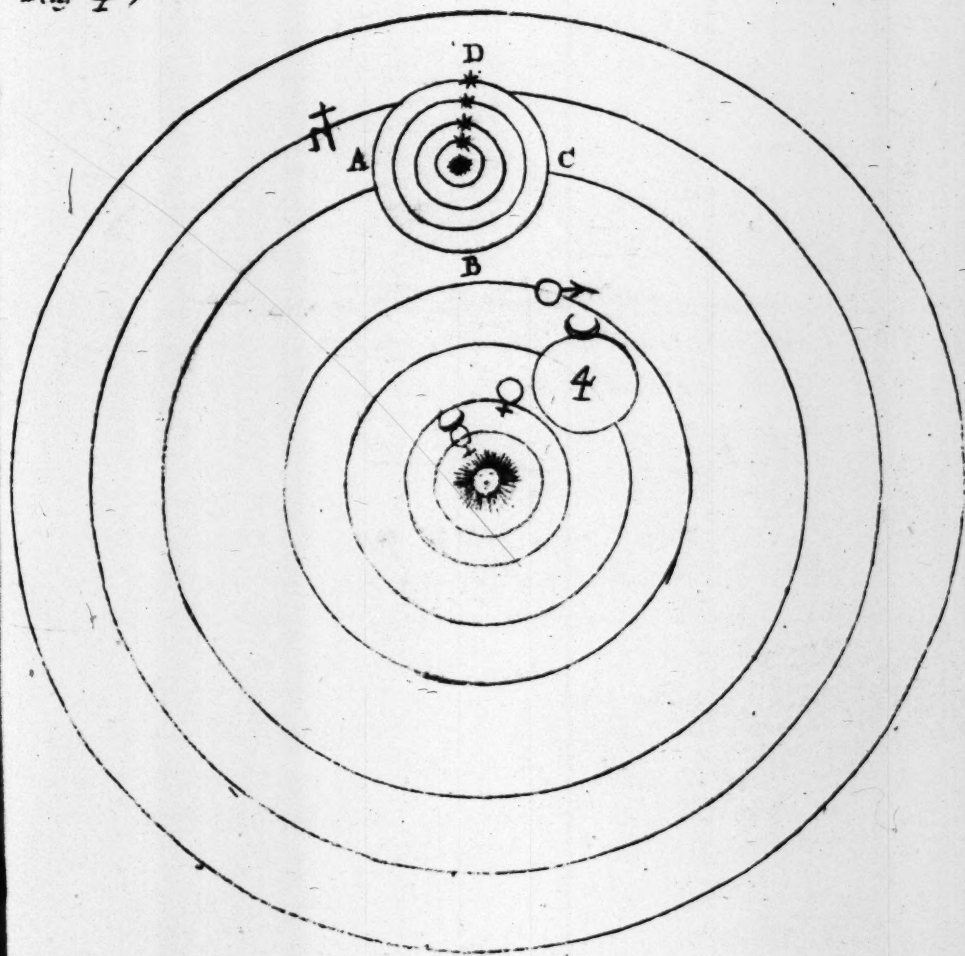


Fig 11



sixth is the Orb of *Venus*, marked  $\gamma$ : The seventh of *Mercury*: In the midst of all stands the Pavillion of the Sun, whom they suppose only to move about his own Center in twenty seven days or thereabouts, which is proved by the Spots observed in his Face by the help of our Glasses, which Spots make their returns to the same point in about that time. The advantages this Hypothesis has above the other, is too long here to insist on; Only I will say there are some very Learn'd Men, who no more doubt that the motion of the Earth will be received generally within a small compass of years, than that now Men believe the Antipodes, or the Circulation of Blood, and think it as much demonstrable as either of them.

Supposing then the Earth to be moved round, the Sun in the Circle here assigned to it, that Circle they call the great Orb, and suppose the Semidiameter of it to be equal to 1500 Semidiameters of the Earth, and the Sphere of the fixt Stars to be distant from the Earth 28000 Semidiameters of the great Orb, or which is much about the same, forty two millions of the Earths Semidiameters.

This distance indeed is vastly greater than either that assigned by *Ptolomey* or *Tycho*, but yet admitting the distances assigned by either of the two later, and measuring the

the compass of the Orb of fixed Stars thereby, it is in a manner unconceivable that that Orb can be carry'd round the Earth in twenty four hours, or in a natural day ; for in such case its motion must be many hundred times more rapid or swifter than the Shot out of any Gun. For according to due Computation, the very Sun it self, by the *Ptolomaick* Hypothesis, must move in one minute 13095 *English* Miles, and in an hour 783715 Miles ; but the fixed Stars most vastly more, namely 13513686 *English* Miles in one hour, and in one minute not less than 225228 Miles, which I think no one can well believe. Yet this I say would inevitably follow upon that distance at which *Ptolomey* places both Sun and fixed Stars from the Earth ; and much more upon the distance assigned by the *Copernicans*, only those indeed help themselves by supposing the Earths daily motion upon its own Ax.

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## S E C T. IX.

*Of the best way and times of using Instruments to satisfy our selves in these Curiosities.*

**T**Hat the Quadrant (or where a large Quadrant cannot be managed, a Sextant) and Telescopes are the most useful Instru-



Instruments for both making and satisfying our selves in Discoveries of this Nature, I think will not be doubted. But certainly the best way to use them is in conjunction. Its true there may be several cases in which we respect not much the height or place of a Star ; it may be all we design is to view its Colour, Form, Spots, or the like, and then the Telescope it self may suffice. But because Stars appear of different Diameters or sizes, according to their different height or position above the Horizon, therefore we shall be able to make the exactest Observations and truest Judgment, if we have to the side of a large Quadrant (or Sextant) duely fixed a proportionable Telescope joyned and fastned. The way of fixing both it is scarce possible in words so to describe as that it will be plainly understood. But these things may easily be seen, and then most readily understood, if we go to any Artists. And being furnished with such a Machin or Instrument, the best time to use it is not in the lightest Nights, or when the Moon is at Full, ( except on some particular occasions ) for then the Luminous Raies too much confound one another. It is much best viewing the Moon at or near its Quarters. But if we will see a Full Moon, we must have larger and longer Telescopes than such as can be fixt to Quad-

E

rants :

rants: and there are little Devices to draw the Raies closer by putting a Paper with a Pin-hole in it betwixt our Eye and the Glass, and the like with a little use will easily direct and teach us to contrive.

Then for the Stars, the best time to view any of them is in clear Nights, when there is little or no Moon. A Telescope of six or eight foot will for these, and indeed for the Moon or Sun also, do in a manner as well as one of twenty four or twenty five. The disadvantage of cumberfomness in these large ones is such as scarce countervails the advantages which they have; the chiefest of which is, that they take in a greater part of the Heaven than our lesser Glasses.

But all Persons must be advised how they venture to look on the Sun with Telescopes. For in due position the whole Instrument is but as one violent Burning-Glass, and a Man may easily take such a look in an instant as never to see more with that Eye. Therefore some use to smoak their Glass over a Candle; but the best way is to have a small piece of red or purple Glass to interpose betwixt your Eye and the Glass of the Telescope, and by this means you may view that glorious Body with little or no prejudice. But as to these points, those  
who

who sell these Instruments will certainly, if desired, shew their Customers the truest and safest way to use them, more plainly than I can speak. I will only here add, that if we design a clear sight of the face or bigness of any of the Heavenly Bodies, the worst time to view any of them is when they are not far from the Horizon; for then the refraction of the Raies is so great, that their Bodies appear much larger proportionably than at other times, and in other positions, and the sight of them too is much more confused; By which one note, any Person may be able to direct himself what Stars are in a most convenient condition for him to view at any time, when his Curiosity leads him to such Entertainments. And truly these are Entertainments so noble and glorious, as well as ravishing and transporting, that it is to be wondred how Persons whose Parts and Fortunes qualifie them for them, are able to temperate themselves from them.

But perhaps it will be said the uncertainty of the truth of them discourages. Of that therefore we will consider in the next place.



## S E C T. X.

*What certainty there may be concluded in these  
Curiosities and Discoveries.*

**T**O come to a perfect and exact knowledge of the distance of the Heavenly Bodies, (by Miles or such known measures) of their bigness, substance, frame, and contexture is not to be expected: nor will any, except Madmen, pretend to have made such Discoveries. There are very few things which Wise Men will say they thoroughly understand, even amongst these Sublunary Bodies. But there is as great a difference betwixt the knowledge which Artists and Speculative Men have of the Heavens, Stars, and Orbs, and that which the Common People have, as there is betwixt the Common Peoples and Brutes notions of them. To come to particulars.

The Parallax of the Moon is very sensibly discoverable. Its Horizontal Parallax is above a whole Degree. Therefore the distance of the Moon may be more certainly concluded upon, and more firmly credited. In the other Stars I confess the Case is more difficult, and the Work finer, so  
that



that the Result exceeds not probability. For in *Mercury, Venus, the Sun, and Mars,* we cannot without great difficulty observe any Parallax, and that which we can at length observe is very small. In *Jupiter* and *Saturn* there is scarce any. And as to the fixed Stars they are so vastly above us, that we are to expect none in them. The reason hereof is, that the Semidiameter of the Earth, which is taken in these Cases for the common Measure, and as the interstice between the two supposed Dimensory Stations, bears some sensible proportion to the distance of the Moon; but as to the distance of those other Bodies, its proportion is so very small, as almost to vanish when applied thereto. As if the Earth were but in comparison of them as a Point, and there were no difference whether we beheld them from the Surface of the Earth, or from its Center. By which ingenuous dealing the Reader will be able easily to gather what kind of belief he is to give to the foregoing Calculations or Accounts of the distances and Magnitudes of these Bodies. They are mostly but the Conjectures of Men very learned, knowing, and industrious in this kind.

And

And as to those Discoveries mentioned in the first part of this Book, it may perhaps be suspected they are also as uncertain, because of the diversity of Refractions and *Mediums*, the vast distance and other like Points. But it is to be said hereto; Those Objects which constantly through divers Glasses, at divers times, and by divers Spectators observed, still generally, or most commonly appear the same, are certainly as they appear. *Saturn* therefore most surely has such *Ansule* of Light as he is represented. *Jupiter* has such Obscurer Tracts as those termed his *Belts* or *Girdle*. *Mars* such Features as I may call them as above described. The *Sun* and *Moon* such *Spots*. And *Venus* her different *Phases*, sometimes as an Half, Quarter, or Full Moon. And there are none of these but are far a more glorious Light than they can be conceived, when seen only in such Figures, as we have been able to represent them in. The seeing them as near as we can by the help of our Glasses, in themselves fills the Fancy with delightful new Idea's, and the Understanding with new curious Contemplations, and prepares and raises the Mind to most Noble, Curious, and Divine Speculations, as well as Wonder and Content. Then as to those *New Stars*, (as I may call them) that

that is, such Stars as we cannot espy with our naked Eye, but do plainly see, and can count with the help of our Glasses; (such as are not only very many little ones, but one larger of the seven Stars in the *Pleiades*, that infinite multitude in the *Galaxy* or *Milky Way*, &c.) These are most certain things, and not meer appearances: because if an hundred People look at them, and have one hundred Telescopes, they shall all see the same Stars, and be able to count them, and describe their Position, or the Figures they make as they stand all along in the Tracts of the Heavens. These therefore can be no sparklings of Light, or false appearances in the Glasses, but must be real and proper Stars: some of them certainly very vastly above the others, and having different Centers of motion, or different Orbs from the others. Most of these things therefore cannot be doubted.

And *de facto*, it is not now doubted, I think, by any who have used Telescopes in viewing the Heavens, that in the *Firmament*, as it is usually called, or Sphere of fixed Stars, there are several Stars which have a peculiar motion of their own, and are as it were Suns too, and illuminate others, as our Sun does the Moon and other Planets.

But



But the Theory of these things would lead us into heights as far beyond our Conception and Comprehension, as above our Sight. We will therefore here sit down a while and wonder, and put a stop to our thoughts of the Stars.

*Soli Deo Gloria.*





